SCIENCE INFORMATION NOTES

A collection of articles on scientific and technological matters, research policies, science and society, higher learning etc.

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SCIENCE INFORMATION NOTES
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India joins the space-launch club

Not quite 23 years after the Soviet Union's momentous launching of Sputnik 1, 15 countries have had satellites of their own in space (Australia, Canada, China, Czechoslovakia, France, Great Britain, India, Indonesia, Italy, Japan, the Netherlands, Spain, West Germany, the United States and the USSR). Far fewer, however, have actually been able to put them there. For years, the United States and USSR launched everything that went into orbit, forming an exclusive club that was subsequently joined only by China, France (which is also the primary builder of the Ariane rocket for the European Space Agency), Great Britain and Japan - until last week. The newest member is India, which on July 18 sent a tiny test satellite into orbit aboard a four-stage, solid-propellant rocket launched from Sriharikota on the country's southeastern coast.

The 35-kilogram satellite, designed merely to report on the flight environment and the shape of its own elliptical orbit, was India's third. The previous two were launched by the Soviet Union, whose space links with the subcontinent also include the possibility of training some Indians as cosmonauts. The new rocket (whose maiden flight last August ended in failure) is not from Soviet designs, however, according to Indian officials, but evolved from India's own sounding-rocket research, which has been going on since the 1960s. (Japan's first orbital launching, by comparison, used a rocket based on a U.S. design, although a Japanese-designed rocket has since matched the feat.)

Satish Dhawan, chairman of India's policy-making Space Commission, also said on the day of the launching that the new rocket gives the country the capability of developing intermediate-range ballistic missiles, since "any country which can place a satellite in orbit can develop an IRBM." A four-stage rocket, depending for success on a series of properly executed firings, might be an unlikely choice for an IRBM, but last Friday's launching could be seen as relevant to an appropriate guidance system. In addition, officials report that Indian researchers are at work on liquid-propellant technology.

The Indian Space Research Organization, meanwhile, is planning to launch a scientific satellite with the new rocket next year. A remote-sensing satellite for earth-resources studies is in the works for 1984 or 1985, although its projected 500-kilogram weight is about 10 times the payload capacity of at least the present version of the rocket. This could well mean that it will be orbited by a different vehicle entirely, such as ESA'S Ariane, Indian officials acknowledge. It is possible, in fact, that an Ariane will launch India's next satellite before either of the above probes has flown. An Indian experimental communications satellite called Apple is due to ride an Ariane officially scheduled for November, although the recent failure of Ariane's second test flight may have delayed the flight into 1981. India's new rocket is thus not an automatic entree to orbit, at least for the time being, but the launch capability does put the country in exclusive company.

(Science News, 118, 4 (July 26, 1980) p. 53)

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NOBEL LAUREATES
(Extracts)

The Royal Swedish Academy of Sciences, in its wisdom, has again decided that molecular biology is really chemistry and has awarded this year's chemistry prize to three molecular biologists, Paul Berg, Walter Gilbert and Frederick Sanger. Gilbert and Sanger are honoured for developing methods that have drastically reduced the amount of work needed to decode a stretch of DNA, making it possible to attempt research that was unthinkable a decade ago, while Berg is cited for his "fundamental studies of the biochemistry of nucleic acids with particular regard to recombinant DNA".

Berg, professor of biochemistry at Stanford University, is probably best known as the moving spirit behind the "Berg letter", which asked scientists voluntarily to suspend certain types of genetic engineering - but that, ostensibly, is not why he won the prize. Rather he received it for developing the techniques that he later asked scientists to eschew.

Genetic engineering depends crucially on a few techniques, among them techniques for joining, or splicing, one bit of DNA to another. Berg was instrumental in devising the splicing techniques...

...Berg wanted to isolate a gene from one organism and transfer it into another, where he could investigate its workings in relative isolation, away from all the other genes of the first organism. Bacteriophages, tiny viruses that attack bacteria, inject their own DNA into the bacteria, where it takes over the bacteria's machinery for its own use. If Berg could persuade a phage to take up some DNA from one organism and transfer it to another,, he would have the technique he was looking for...

...Frederick Sanger is only the second person to win two Nobel prizes in the same field (the other is John Bardeen of the University of Illinois at Urbana-Champaign, who took the physics prize in 1956 and again in 1972)...

....Sanger perservered and developed a number of techniques for reading off the sequence of bases in DNA, each more efficient than the last...

...Sanger's work always has a catalytic effect on a number of fields, and that is why it is so important," says George Brownley, professor of pathology at Oxford University...

...Walter Gilbert, now professor of microbiology at Harvard University, started life as a physicist. He got his doctorate in physics at Cambridge in 1956, where he was friendly with James Watson, co-discoverer with Francis Crick of the double-helix structure of DNA...

...The Nobel committee gave half of the prize to be shared between Sanger and Gilbert, and cited "their contributions concerning the determination of base sequences in nucleic acids", so it seems reasonable that, despite the importance of his work on the repressor, Gilbert is being honoured for his own rapid method of determining the sequence of bases in DNA...

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(The physics prize this year awarded to Val Fitch and James Cronin for their intriguing research on close encounters of the K meson kind)

...Until 1964 physicists could define no test to distinguish unambiguously matter from antimatter outside Earth's relatively small sphere of influence in space - our own galaxy, and maybe a few others nearby. Then, James Cronin and Val Fitch, working at Princeton University with James Christenson and Rene Turlay, stumbled across an effect that provided a solution...

...They were studying the properties of K^0 mesons - neutral, unstable particles with roughly half the mass of the proton. These had been discovered earlier in the interactions of cosmic rays (particles from outer space) with Earth's atmosphere. K^0 mesons are the surprise cards in nature's pack, for a K^0 is a mixture of two "basic states" called K^0_L and K^0_S where L and S stand for long and short and describe the relative lifetimes of these two states. The K^0_L state lives for nearly one ten millionth of a second before decaying to other particles, while the K^0_S lasts merely one ten billionth of a second. But these two basic states can also mix in another way to form an antimatter particle, the anti-K^0; and in practice the K^0 can oscillate from particle to antiparticle through either of its base states - a unique phenomenon in the world of particle physics.

Cronin and Fitch had set out to study one consequence of this mixing - but they found something totally unexpected in the way K^0_L states decay. K^0 mesons prefer to decay into pi-mesons, particles of a little more than 1/4 the mass of the K meson. And a rule called "CP conservation" says how the K^0_L and K^0_S should decay.

...Cronin and Fitch found that the K^0_L can decay into two pi-mesons - about 0.2 per cent of the time - violating CP conservation. The small size of this effect and the fact that it was totally unexpected are a measure of the two physicists' achievement. The immediate effect of their surprising discovery was to spur others to check the result at other particle accelerators, and to generate a rash of what now seem to be bizarre explanations. The conclusions that had to be drawn were that decays of the K^0_L mesons are different from all other known particle interactions and do indeed violate the rule of conservation...

...Fitch, now Cyrus Fogg Bracket professor of physics is at Princeton University and currently working on an experiment at Fermilab in Illinois... Cronin, is professor of physics at Chicago University...

(New Scientist, 88, 1224 (Oct. 23, 1980) pp. 217-19)

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Tube worm plants
By P. Young

The discovery of hot-water springs deep in the Pacific Ocean delighted marine biologists, who found the springs teeming with new species and families of crabs, mussels, clams, snails, and crimsontipped tube worms. But the rich abundance of animals at depths of more than one and a half miles proved only the first surprise. Studies of the bacteria that form the base of the food chain at the hot springs have shaken a fundamental tenet of biology.

All life on earth, biologists have held, depends at least indirectly on the energy of the sun, which is captured by plants through photosynthesis. But in January of 1979, biologists Holger W. Jannasch and Carl O. Wirsen of the Woods Hole Oceanographic Institution discovered bacteria growing in the hot springs that do not use sunlight in any way. Instead, these strains use toxic hydrogen sulfide from inside the earth as their energy source.

New, three researchers in California have discovered that the giant tube worms at the vents also are using the hydrogen sulfide. "It means there is an animal that can do things that we thought only plants could do," says biologist J. Frederick Grassle of Woods Hole. "It lives on an inorganic chemical directly."

Two sets of ocean hot springs, or hydrothermal vents, are known. The first was discovered in 1977 by a team of earth scientists 200 miles northeast of the Galapagos Islands. Biologists, led by Grassle, first visited the springs early last year. In April 1979, the second site was discovered at 21 degrees North Latitude, south of Mexico's Gulf of California.

The hydrothermal vents are located at spreading centers, where molten rock rises from the earth's mantle to form new crust. As sea water seeps down through cracks in the new crust, it is superheated and rises through the sea floor; at 21 degrees North temperatures reach 660 degrees Fahrenheit.

The bacteria grow rapidly in the springs, clinging to rocks before sloughing off and rising with the warm water. At least 250 strains of bacteria have been found in the vent waters. Only about a dozen are strict chemoautotrophs - using chemicals, in this case hydrogen sulfide, rather than sunlight to synthesize their own food.

Though the chemoautotrophs' use of hydrogen sulfide for energy is not unprecedented, the source of the chemical is. The hydrogen sulfide used by previously known bacteria is of biological rather than geothermal origin. It is produced as a waste product by another class of bacteria that, in turn, depend indirectly on the products of photosynthesis. The hydrogen sulfide at the hot springs is produced when the scalding water reacts with the chemicals in the rocks.

"What is unique about the bacteria at the hydrothermal vents," Wirsen says, "is that an entire ecosystem depends on geothermal rather than solar energy to sustain life. And because a few strains of bacteria can take this energy and produce cells and other molecules, a surprisingly varied and complex array of organisms thrive in the vent area."

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The tube worm's taste for hydrogen sulfide is even more intriguing to scientists. These animals, which grow at least five feet long and live in white tubes that reach more than eight feet tall, have neither eyes, mouth, gut, nor anus. It was assumed they lived by taking up organic matter from the sea. Instead, Horst Felbeck and George Somero of the Scripps Institution of Oceanography and Gregory Rau of the University of California at Los Angeles found that the tube worms mimic the autotrophic bacteria.

"Hydrogen sulfide is extremely toxic," Somero says. "You can't sit down and make a meal out of it. But that is what the tube worms do. They have some of the same enzyme systems as plants. What they are doing is manufacturing carbohydrates in ways similar to those used by photosynthetic plants and bacteria."

The discovery raises the possibility that other sea animals also live without benefit of the sun. "The idea is so foreign to animal biologists that no one has really looked," Somero says.

(Science 80, 1, 5 (July/August 1980) pp. 85-86)

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In Praise of Smallness

Erwin Chargaff (Columbia Univ.) in Perspectives in Biology & Medicine 23(3):370-85, Spring 80

..."An organization designed to support small science must consider the special case of the retired scientist who may want to continue his research activity. The stupidly arrogant manner in which the elderly are treated had struck me long before I reached their unenviable ranks; and the elderly scientist is at a double handicap: he has no 'peers,' for the beavers who judge him are not only inordinately eager, but also excessively young; and, besides, he often has lost the ability to swallow his pride and to suffer fools with the gladness required by our time. (I have seen letters of refusal whose tone adds no page of glory to the annals of American science.) In my opinion, a sufficient number of special grants ought to be reserved for retired scientists who sometimes are, in fact, much better than their louder-mouthed non-peers who sit in judgment. Therefore, these 'golden age' applications ought to be screened by special panels if such can be found."

(Source: Current Contents - Life Sciences, 23, 43 October 27, 1980) p. 11)

* *

Promoting the Rational Use of Living Resources

By Edouard Saouma

(Summary)

The opportunity of agriculture to use, during the last three to five decades, abundant and cheap sources of fossil-fuel energy, has enabled farmers to enjoy an extraordinary growth of output in developed countries and in some sectors of the Third World. Unfortunately this technical revolution has not had wholly beneficial effects: pushed to its extreme it is detrimental to the environment, creates little new employment, and can even increase unemployment. Moreover, it is by no means always adapted to the needs of the hundreds of millions of poor farmers and landless labourers in the Third World, and henceforth the emerging energy crisis will surely question the wisdom of pursuing this agricultural technology.

In future the world will have to increase its agricultural production to feed a human population which is now projected to reach some 6,3 thousand millions in 2000, and must somehow accomplish this without affecting the environment adversely or the perpetuity of natural resources too seriously. To meet such a challenge, and also to lead rich and poor countries to understand one another better than at present and really work together, a joint design and policy of action is proposed along the following lines: As both groups of countries are faced with the energy crisis and increasing degradation of their environment, the rich and poor nations would have a common interest in laying the foundations for what might be called the Third Agricultural Revolution. This 'revolution', based on the laws which govern the environment - including sound ecological principles and embracing the ongoing biological revolution - should be in part a synthesis of the two preceding ones, namely the agricultural aspects of the general industrial revolution of the 17th and 18th centuries and of the technological one of the beginning of the 20th century which, of course was based on abundant and cheap energy especially from petroleum.

This joint design may be regarded not only as a factor of unification, peace, and harmony in the world, but also as an important aspect of a 'New International Economic Order.'

(Environmental Conservation, 7, 2 (Summer 1980) pp. 93-97)

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Potentials and Problems of Hill Areas in Relation to Conservation of Wildlife in India

By G.M. Oza

(Summary)

Basically through population pressures leading to habitat encroachment and commercial slaughter, India is becoming poorer, day by day, in her still-rich heritage of wildlife. Virgin forests on the plains and in the hilly regions are dwindling. Unfortunately, education and research centres have not cared to educate the youth of the country about the importance of nature conservation.

The Author's field endeavours, extending over more than a decade, have helped to reveal that 18 of India's 27 threatened mammalian species - Lion-tailed Macaque, Nilgiri Langur, Golden Langur, Snub-nosed Langur, Wolf, Asiatic Wild Dog, Malabar Large-spotted Civet, Clouded Leopard, Indian Tiger, Leopard, Snow Leopard, Asian Elephant, Sumatran Rhinoceros, Kashmir Stag, Gaur, Wild Yak, Nilgiri Tahr, and Markhor - have their homes in hilly or montane habitats. Paradoxically, India has the dubious distinction of ranking second in the world, and first among the 15 countries of the Oriental region, in having 27 mammalian species whose world populations are to some extent threatened according to the Red Data Book (IUCN, 1972).

This contribution is presented to the legions of Indian nature lovers and to all others who are concerned with wildlife conservation, with a view to conserving potential regions in India from the depradations of Man - whose actions are commonly selfish and mostly for momentary economic gain. The Author's ultimate desire is to help stimulate the preservation of populations of native plants and consequently to prevent the extinction of the world's unique wildlife which should be conserved for the benefit of future generations.

The most essential actions to conserve vanishing animal wildlife in India are: limiting agricultural and animal husbandry practices in wildlife habitats; preserving indigenous floristic elements in the areas where the wildlife survives; discouraging introduction of foreign importations, especially to the Indian flora; curbing poaching activities; restricting human settlements in the Indian forests - particularly in the National Parks and Sanctuaries; halting of indiscriminate clearing of forests on mountain slopes for immediate commercial gain; implementing conservation measures for ensuring survival of endangered species; breeding endangered wildlife in captivity-farming for stocking purposes; establishing inviolate reserves for maintaining viable populations of prey animals; staffing with trained game wardens in the field; limiting human disturbances in natural habitats; and banning firewood collection in all the Indian Sanctuaries.

(Environmental Conservation, 7, 3 (Autumn 1980) pp. 193-200)

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Nature Conservation in Rhodesia : A Review
By D.N.S. Tomlinson
(Abstract)

The history of conservation is outlined and the present status and aims are reviewed. There are six types of conservation area in Rhodesia which are listed and described in terms of their present location, size, floristic and faunistic components, planning stage, conservation and management status. Management problems are defined and the ongoing research programme is tabulated. The need for a reappraisal of practical management and planning principles are discussed using a case history as an example.

(Biological Conservation, 18, 3 (Sept. 1980) p. 159-77)

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The Future of the Scientific Endeavor
Philip Handler (National Academy of Sciences) in Canadian Journal of Biochemistry 58(3):156-60, Mar 80

..."Twenty years ago the major scientific and societal problems still fell reasonably neatly into the old disciplinary compartments of physics, chemistry, geology, and biology, etc., although biochemistry itself was something of an awkwardness. But that facile compartmention no longer is, or seems, quite so relevant. The very success of science has created new sets of problems which cannot be quite so neatly encompassed. The biosocial problem of population control, the environmental crisis, the information explosion, the energy problem, the future of developing nations, even the relationship between brain and mind, the genesis of life, or the etiology of cancer can no longer be managed by a single classical discipline. And so, what scientists, from their disciplinary standpoint, deem as scientific progress, may new seem questionable or irrelevant to the public at large."

(Source: Current Contents - Life Sciences, 23, 34 (August 25, 1980) p. 15)

How to save the world
By Robert Allen
(Extracts)

... No creature can be in a predicament more treacherous than the one in which human beings find themselves today. To survive, every species must modify its environment. But human societies are altering their environments so drastically - whether out of ignorance, greed, irresponsibility, or the desperate struggle to escape the trap of poverty - that they are making their survival unlikely if not impossible. It is as if the only means of improving our planetary home was to knock down the walls and bulldoze the foundations.

Although environmental modification is natural and a necessary part of development, this does not mean that all modification leads to development, (nor that preservation impedes development). While it is inevitable that most of the planet will be modified by people and that much of it will be transformed, it is not at all inevitable that such alterations will achieve the social and economic objectives of development. Unless it is based on conservation, much development will continue to have unacceptably harmful side-effects, provide reduced benefits or even fail altogether; and it will become impossible to meet the needs of today without foreclosing the achievement of tomorrow.

The way to save the world is to invent and apply patterns of development that also conserve the living resources essential for human survival and well-being. Living resource conservation is often thought of and treated as a specialised and somewhat limited activity, but in fact it is a process that cuts across and must be incorporated in all human activities. For this to be achieved, each of us will have radically to re-orientate our view of the World and of our place and role in it. Meanwhile, it is essential that conservation and development be fully integrated without delay to ensure that, in their quest for a higher quality of life, people protect those parts of the biosphere that need protecting and modify the rest only in ways that it can sustain. For this we need a world conservation strategy.

(The Ecologist, 10, 6/7 (July-Aug.-Sept. 1980) pp. 190-94)

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SCIENTIFIC MATERIALISM
The strait-jacket of Western Culture
By Robert Waller
(Extracts)

... While recognising the limitations of scientific materialism, we must not be tempted to suppose that the idea of progress is nonsense. If we go back to the Middle Ages we see that it was an idea arising from a new use of the imagination and intellect. It added a new dimension to human life that had not previously existed. If wealth could be increased by taking thought, by constructing machines, by devising better methods of cultivation, then man would have no need to rob his neighbour, loot and conquer in order to increase his wealth. It could be done by industry and trade. Machinery was to take the place of slaves. It is absurd to grovel in front of God and treat every innovation as a sin. God has given us a mind, let us use it. The Reformation,

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T
the Enlightenment and the Industrial Revolution are a chain of linked events. They created, as we have seen a new optimism about man's capabilities and future. To let go of this and to revert to a sado-masochistic fatalism would be a tragedy.

Progress was a real hope and has only become a tragedy because it has not been properly thought out. It has been carried too far along 'rational' lines; in our native enthusiasm for acting upon the world, we have sacrificed the inner life. Progress has been arrested and imprisoned in the philosophy of scientific materialism. The 'rational' has dominated the 'irrational', that is religion, philosophy and art. What do the mind and the intellect serve? Do they serve love or do they serve greed and vanity? We have made a fine weapon of the scientific intellect no doubt, but it has ceased to serve the higher needs of mankind; it will not subordinate itself to the soul. The time has come to correct the balance; for the imagination to topple the presumptuous intellect from its throne and make it the servant of the spirit. In fact what we need to be is double revolutionaries changing both the inner and the outer life; active mystics...

(The Ecologist, 10, 6/7 (July - Aug. - Sept. 1980) pp. 224-29)

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Asteroid Theory of Extinctions Strengthened

By Richard A. Kerr

(Extracts)

The abrupt disappearance of all the dinosaurs about 65 million years ago, along with perhaps half of the plants and other animals, has been one of the great geological mysteries. Clues to the cause of these extinctions have been scarce and open to innumerable interpretations. That may be changing. Last year, a group at the University of California, Berkeley, claimed to have found chemical traces of what may have been the ultimate cause of all the extinctions- dust from the impact of a 10-kilometer-wide asteroid that hit Earth at the geological instant of extinction.

Since last year, the Berkeley group and investigators at other laboratories have gathered evidence confirming the extraterrestrial origin of the traces of exotic metals that had been found. They have also shown that the chemical clues are scattered worldwide in six areas in Europe, Europe's antipode New Zealand, and the central North Pacific. With that kind of evidence piling up, researchers now believe that any explanation of the extinctions must also account for the new geochemical evidence.

....For one, they suggested an asteroid rather than a comet. Enough asteroids are known to cross Earth's orbit that one 10 kilometers across, large enough to account for the concentration of iridium at Gubbio, would hit Earth every 100 million years on the average. When it hit Earth, probably while traveling at roughly 90,000 kilometers per hour, part of its 100 million megatons of kinetic energy could have been consumed in throwing tens of quadrillions of tons of pulverized rock into the stratosphere, according to the theory. The dust would be so thick for several years that the sunlight reaching the surface of Earth would equal only 10 percent of full moonlight. Plants would die in the sea and on land, food chains would be shattered from the bottom up, and the extinctions would follow. The 175-kilometer-wide crater left by the asteroid may be somewhere beneath the sea because no such crater has been found on land...

Researchers in other specialties are also comparing observed patterns of extinction with the Berkeley group's speculations. Some evidence runs counter to the sun-blockage theory, such as the minor changes among freshwater plants and animals. Paleontologists view the fossil record of some other groups, such as that of the mammals, as too incomplete to permit a strong statement one way or the other. They do not even agree on whether the dinosaurs met a sudden end. The strongest evidence for instantaneous extinctions remains the marine microfossils.

Although more paleontologists would prefer a gradual over a catastrophic cause for the extinctions, paleontological evidence alone is not likely to resolve the question. The fragmentary geological record, imprecise measure-

Contd.---

ment of geological time, and the extreme specialization of fossil studies work against it. Paleontologists faced a similar problem when the possibility of drifting continents forced itself upon them. In the end, marine geophysicists and geologists presented them with the answer that continents do move. Now, paleontological speculations based on geochemical evidence are stimulating an unprecedented burst of interest in the cause of mass extinctions. The difference again is that the new theory is obviously testable.

(Science, 210, 4469 (Oct. 31, 1980) pp. 514-17)

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Making Science-Advising Work
In Washington Post 16 Jun 80

...This editorial asserts that the National Academy of Sciences "has tried to do too much and, in so doing, has compromised the quality of what it can do best. It now supports more than 1,000 committees, covering subjects that range from the vital to the truly trivial... And in growing so big, the academy has gotten sloppy about the two procedures that are essential to maintaining the intellectual integrity of its work. The first of these is the choice of individuals to serve on a study.. The academy duly examines detailed conflict-of-interest forms, but what really matters are intellectual biases... The second and equally important procedure is the choice of individuals to review draft reports. Critical review by a panel of peers is absolutely vital to the conduct of good science. Obvious flaws in these two processes were largely responsible for the recent report by the Food & Nutrition Board that has so badly damaged the academy's reputation."

(Source: Current Contents - Physical, Chemical & Earth Sciences, 20, 39 (Sept. 29, 1980) p. 23)

Black holes take on gravity theory
By Dr. John Gribbin

Just as theorists are getting used to the idea that black holes might evaporate, and are not really "black" after all, Frank Tipler of the University of Texas at Austin has come up with the suggestion that black holes may not even exist. The problems really began with Stephen Hawking's work a few years ago. Hawking, the Cambridge mathematician widely regarded as the nearest thing we have to a new Einstein, showed that by combining quantum mechanics with relativity it was possible to show that particles could be created in pairs just outside the horizon of a black hole.

With one particle falling into the hole and the other shooting off to infinity, and hole would steadily lose energy and mass until one day it was too small to be "black" any more, and burst out into full view. But his timescale for the process suggested that a black hole that contained the same mass as the Sun would stay around for much longer than the life of the Universe so far.

Tipler's improved version of the calculation says, by contrast, that the process may be so efficient that even a solar mass black hole would disappear in less than a second. The implication is that stable black holes do not exist - or that there is something fundamentally wrong with our whole understanding of the way quantum effects interact with general relativity and thermodynamics.

The confusion arises because there is no satisfactory quantised theory of of gravitation. Hawking's approximation involved what is called a "semiclassical" technique in which the feedback of the quantum effects on the structure of space-time was ignored. Although this works, in that "answers" do come out of the calculations, the whole point about black holes is that they involve bent space-time, so it would be much more satisfactory to include the second order "bending" due to the quantum effects. Nobody knows how to do this properly; but there is a concensus among relativists about some of the properties of the energy tensor that comes in to the second order equations. These properties are enough for Tipler to show that the second order effects cause black holes to evaporate extremely rapidly (Physical Review Letters, vol.45, p.949).

This looks so unlikely - chiefly because of problems involving what happens to the singularity at the heart of the black hole - that Tipler suggests three ways to avoid the conclusion his analysis points to. First, as others have speculated, it may be that quantum effects stop black holes from forming at all. In other words, black holes may not exist. Secondly, the concensus on the nature of the second order tensor may be wrong, and thirdly, black hole evaporation may not occur at all. Either of those two possibilities means that, despite the apparent break-through of Hawking's work, we don't really know anything about how to combine quantum theory with relativity and thermodynamics after all.

None of the options looks very palatable. Tipler is fond of setting the cat among the pigeons with his esoteric calculations, and has previously suggested that time travel may be possible and that there is no other intelligent life in our Galaxy. His latest effort is likely to cause the biggest flurry of the lot.

(New Scientist, 88, 1222 (Oct. 9, 1980) p. 95)

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Earthquake prediction
By David W. Simpson

In the early 1970s, principally because of observations of premonitory changes in velocity ratio and groundwater geochemistry in the USSR and crustal deformation studies in Japan, there was considerable optimism that earthquake prediction would soon become a reality. The intervening years have seen a greatly expanded program in earthquake prediction in the United States, but negative and conflicting results have dampened some of the initial enthusiasm, if not led to outright pessimism on the part of many U.S. seismologists regarding the practical reality and imminence of reliable methods for predicting earthquakes. At a recent meeting on a wide variety of topics related to earthquake prediction much of the original enthusiasm appeared to be reemerging as it became clear that at least some earthquakes can be, and in fact have been, successfully predicted. It was also clear, however, that no universal panacea can be expected. Premonitory effects appear to vary widely with tectonic environment and earthquake magnitude. The premonitory signatures of large earthquakes in thrust regions of Soviet Central Asia, China and Japan appear to be clearer and to extend over a wider area than any such effects observed so far in strike-slip environments such as the San Andreas Fault of California.

On a time scale of tens of years, gaps in the occurrence of large earthquakes along major plate boundaries have proved to be one of the most successful methods for predicting the sites of future great shocks. Nishenko, McCann and Sykes (Lamont-Doherty Geological Observatory, Columbia) presented a map of the current 'seismic potential' of the circum-Pacific belt, in which they refined the idea of seismic 'gaps' by ascribing a high seismic potential to a gap only if historical or tectonic data indicate that it is a region capable of producing a large shock. Sykes et al. (Lamont-Doherty) used historical reports to extend the record of great earthquakes in the Alaska-Aleutian arc back to 1784 and showed repeat times of 50 to 100 years for great earthquakes in some regions. Large segments of this part of the plate boundary seem to rupture in temporally clustered sequences of large earthquakes (e.g., 1898-1907 and 1938-1965), separated by long periods of relative quiescence. Variations in seismicity [illegible] especially a south to north migration in the area to the west of the 1946 Nankaido earthquake were reported by Mogi (Tokyo University). He also showed how a recent model by Shimazaki and Nakata, in which rupture occurs at a constant ultimate stress (as opposed to a model of constant stress drop during an earthquake), can be used to explain the observation that the time interval between large earthquakes in western Japan is proportional to the stress drop in the preceding large earthquake. Takagi (Tohoku University, Japan), in a detailed study of activity before and after the 1978 magnitude 7.4 Miyagi-oki earthquake, showed a migration of foreshocks towards the boundary between the oceanic slab and overriding plate, with aftershocks clustering along the boundary. Seismicity patterns in the Mexico-Central American segment of the circum-Pacific belt were described by McNally (California Institute of Technology). Ohtake et al.

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(National Research Centre for Disaster Prevention, Japan) and Singh et al. (Instituto Geofisico, Mexico), who reviewed data which led to the successful prediction of the 1978 Oaxaca earthquake and showed repeat times of 30-40 years for this region. For at least 50 years following the 1906 San Francisco earthquake the level of seismicity in northern California was considerably lower than it had been in the preceding 50 years. Ellsworth et al. (US Geological Survey) suggested that a pair of magnitude 5.5 earthquakes in the San Francisco area in August 1979 and January 1980 show the activity to be returning to a more normal level. Pairs of earthquakes with similar temporal clustering have occurred a number of times in the area since 1836.

In continental areas, where the repeat times for large earthquakes are longer than for oceanic subduction zones and are usually beyond the range of instrumental or historical catalogues, geological data are being used to extend the record of occurrence of major earthquakes. Sieh (California Institute of Technology), Wallace (US Geological Survey) and Schwartz et al. (Woodward-Clyde consultants, San Francisco) showed how detailed mapping of displacement on major fault zones in the western US can be used to date past earthquakes to determine recurrence intervals and maximum magnitudes of prehistoric events. They showed a general increase in the recurrence interval from west to east; from tens to hundreds of years for large earthquakes along the San Andreas system to hundreds to thousands of years in Nevada and Utah.

Whereas most methods for long-term prediction are based on regularities and changes in the seismic cycle itself as revealed by seismicity data, many intermediate and short term predictions rely strongly on indirect indicators of the earthquake preparation process. Aki (Massachusetts Institute of Technology presented a method by which information from various independent prediction can be combined to improve estimates of the probability of the occurrence of a large earthquake. Thatcher (US Geological Survey) showed how geodetic measurements have been useful, especially in Japan and California, in identifying areas of increased stress as the possible sites for future earthquakes. The importance of inhomogeneities in the stress distribution on fault zones and the role of asperities in controlling the release of stress were discussed by Kanamori and Lay (California Institute of Technology) and Wyss (Institute fur Geophysik, Zurich). A model of time dependent failure due to stress corrosion, in which the growth of cracks is controlled by a 'stress intensity factor' and the presence of asperities, was presented by Scholz et al. (Lamont-Doherty).

In short term predictions, water-related effects are especially common. A number of papers described the observation of changes in radon content in groundwater and deep wells. Fu (State Seismological Bureau, Peking) and Wakita (Tokyo University) reported a variety of short-term precursors preceding recent earthquakes greater than magnitude 7 in China and Japan, many of which may be closely related to groundwater (e.g., water level, geochemical and temperature changes in wells, resistivity variations). Sobolev (Institute of Physics of the Earth, Moscow), in a summary of studies in Soviet Central Asia, showed premonitory changes of water levels in wells as far as 650 km from earthquakes of magnitude 7.

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Reviews were presented of the national programs in earthquake prediction in the US, USSR, China and Japan. As described by Mogi (Tokyo University) and Ishikawa (Tokyo Institute of Technology) the Japanese program, which began in 1865, involves a closely integrated organization of universities and government agencies monitoring a wide spectrum of geophysical, geological, geodetic and geochemical parameters, with special emphasis on the Izu Peninsula and Tokai district. In addition to the high level of data gathering and research the Japanese have also made significant advances in raising public awareness of earthquake hazards and in preparing the public for earthquake emergencies. Participants at the meeting were vividly reminded of the sociological and economic importance of earthquake prediction by a series of Japanese films on the disastrous effects of major earthquakes and a Chinese video-tape showing the destruction caused by the 1976 Tangshan earthquake.

Large earthquakes occur in cycles which are long compared to the instrumental records available of seismicity and related geophysical parameters. The seismic cycle appears even longer when viewed in terms of the relatively short time during which data have been gathered specifically for earthquake prediction purposes. Even within the limitations of existing data, however, the meeting clearly showed that consistent patterns are emerging. As data gathering and interpretation improve, the challenges of the next few years will be to identify the techniques which are the most reliable; to test the significance of predictions based on those methods; and to integrate various techniques into an increasingly reliable procedure for earthquake prediction.

(Nature, 286, 5772 (July 31, 1980) pp. 445-46)

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Soviet geophysics

Drilling deeper

By Vera Rich

Soviet geophysicists have had to rethink their models of the deep strata beneath the European part of the USSR, after processing the preliminary data from the super-deep borehole now being drilled on the Kola peninsula. And, according to Professor Vladimir V. Belousov, head of the Scientific Council on the Earth's Crust and Upper Mantle of the Department of Earth Sciences of the Soviet Academy of Sciences, two and possibly three more such holes will be started in the near future.

The Kola bore can advance at a rate of some 10-12 m per day, and has now passed a depth of 10,000 m. It is sited in an area thought to be geologically "dead", and without risk of earthquakes or volcanic activity. Core samples, however, have revealed that cracking extends to considerable depths, and at these levels, at a temperature of about 150°C, significant quantities of aqueous solutions, carbon dioxide and helium provide evidence of high geological activity.

This remarkable level of activity is not the only surprising result to have come from the Kola bore. It had been predicted that a transition from granites to basalts would be observed at a depth of about 7,000 m, and that, as the bore-hole went deeper, the angle of inclination of tilted strata would gradually flatten out. But so far it has been granite all the way, though of increasing density, and the angle of inclination of the strata remains constant.

The Kola bore has still another 5,000 m to go before it reaches its [illegible] scheduled depth, but already some of the preliminary data are being used in planning prospecting for new mineral deposits. The other projected bores will also have their practical aspects - the Tyumen' bore will look for deep level oil and gas deposits in Western Siberia, while the Tagil bore will investigate the "foundations" of the Urals - an important range mineralogically.

The most exciting proposal under consideration would entail drilling a bore at the foot of the Avachinskaya Sopka - a large and active volcano in Kamchatka.

(Nature, 287, 5785 (Oct. 30, 1980) p. 774)

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Law of Sea Conference Still in Deep Water

The United Nations Conference on the Law of the Sea (UNCLOS) met in Geneva on 25 July to wind up its ninth session, which, like a feline ninth life, looks like a last chance. The current effort to carry out a comprehensive overhaul of international law applying to the seas began in 1974. Agreement has been reached on most of the nearly 400 articles on the agenda, but the conferees are still at odds on the matter that has been the major sticking point since the conference began - the control of mining operations on the deep seabed.

This has been the main issue dividing the less developed countries (LDC's) and the United States and other Western, industrialized nations. Prospects for a compromise were cast into deeper doubt recently by enactment by Congress of a Deep Seabed Hard Minerals Resources Act. The new act assumes that a Law of the Sea treaty will eventually come into effect and says the purpose of the U.S. act is to provide a "legal regime" to permit the development of necessary mining technology in the interim. The U.S. law even prohibits commercial recovery of minerals until 1988. But many LDC's have said that passage of such legislation by the United States at this point would be regarded as a deliberate affront and could threaten the fragile consensus on which completion of negotiations depends.

The principal issue to be resolved concerns the composition and rules of the council of the proposed International Seabed Authority, which would oversee mining activities. The conferees have already reached accord on a general regime for seabed mining. The LDC's had wanted rights restricted to an internationalized mining organization while the industrialized countries insisted that the licensing system be open to mining companies, whether private or governmental. As a compromise, a "parallel" system was created under which both companies and an international entity, known as the "Enterprise," will operate under the seabed authority.

Tough questions of detail were deferred in dispute in particular is a demand by the United States and other potential mining countries that they have a "blocking vote or veto in the council over issues that they see as clearly contrary to basic national interests.

Other kinds of issues also remain unsettled as, for example, the setting of boundaries in waters claimed by adjacent coastal states. But those affecting the rules of the council appear to be the crucial ones.

What would be the consequences of a failure to reach agreement, particularly if blamed directly on the United States? A suggestion pushed by some American mining interests is that seabed mining be separated from other issues and the matters be handled in separate treaties. Informed observers feel that it is unrealistic to think that the LDC's would accept such a departure from the original understanding that the treaty would be negotiated as a total package.

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One possibility is that failure to agree on the mining issues would lead to the unraveling of the whole fabric of agreements already reached. Many of these points involve navigation and overflight rights in which the United States has a heavy stake. As a country with global military and commercial interests, the United States puts heavy emphasis on freedom of navigation. Since the Soviet occupation of Afghanistan, the taking of the hostages in Iran, and the increase of tensions between the Thais and Vietnamese, freedom of the seas considerations have grown even more important. In recent years, the tendency, particularly among LDC's, has been to extend territoriality offshore and restrict navigation rights. Parts of the Law of Sea text negotiated so far restrain this tendency. In the final phase of negotiations, therefore, the United States appears to face a conflict between economic and political advantage.

With plenty of uncertainties already hovering over the negotiations, a new one is added by the quadrennial possibility of changes at the White House. Advent of a Reagan Administration is apparently viewed by many of the UNCLOS participants as making a U.S. ratification of a treaty harder. Whether this view will make the LDC's more or less amenable to compromise on the outstanding differences is at this point unclear.

(Science, 209, 4457 (Aug. 8, 1980) p. 606)

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Laser Power Satellite?
Ray Sperber (Boeing Aerospace Co., Kent, WA) in L-5 News 5(6):12-13, Jun 80

...The proposed solar power satellite (SPS) would collect solar energy in space and beam it to earth in the form of microwaves. "The use of lasers as an alternate, perhaps more attractive, means of beaming down power from the satellites has been investigated by a number of researchers.... Comparing the best efficiencies projected for the laser SPS system components with those of a microwave system shows that the best laser systems will provide about half as much electric power on earth per unit of intercepted sunlight... Still, there may be situations where the smaller blocks of power that the laser systems can provide onto smaller receivers are useful. Laser-powered airplanes are an example of this."

(Source: Current Contents - Physical, Chemical & Earth Sciences, 20, 39 (Sept. 29, 1980) pp. 23-24)

Solar variability and climatic change during the current millennium
By Minze Stuiver
(Abstract)

Claims of a Sun-weather relationship can only be evaluated properly when the history of solar change is known in detail. The most obvious feature of solar variability is the change over time in the number of sunspots on the visible half of the Sun. A less visible indicator of solar change is the C content of tree rings. The atmospheric C levels derived from tree ring measurements can be tied to the Sun's modulation of the cosmic ray flux in the vicinity of the Earth, and thus provide a history of solar change. We report here a comparison of climate records with the record of solar change obtained from atmospheric C variations. This yielded 'Negative' results, that is, a relationship between the climatic time series and the C derived record of solar change could not be confirmed.

(Nature, 286, 5776 (Aug. 28, 1980) pp. 868-71)

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Observations of dilatancy-induced polarization anomalies and earthquake prediction
By Stuart Crampin et al.
(Abstract)

Much of the search for earthquake prediction schemes has centred on the expectation that rocks in the impending source area will show dilatancy: the opening of cracks at high stresslevels. Recent developments in the theory of seismic wave propagation in cracked media demonstrate that shear-wave splitting will occur in seismic-wave propagation through cracked structures, when the cracks have any overall alignment. This splitting causes polarization anomalies in the seismograms, and it has been suggested that dilatancy, induced by the build-up of stress before earthquakes, might be recognized and monitored by analysis of these anomalies. We present here new observations which support this hypothesis.

(Nature, 286, 5776 (Aug. 28, 1980) pp. 874-77)

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Impacts of Rural Development and Their Assessment in Southeastern Asia

By B.N. Lohani and N.C. Thanh

(Summary)

The overall objective of development should be to improve the quality of people's lives, yet economic development without due environmental protection commonly leads to ecological or environmental impacts which have the reverse effect of reducing the quality of human life. A table showing some of the major environmental impacts that can result from uncontrolled rural development is presented to illustrate the fact that developmental activities with no environmental protection can be very seriously detrimental to the rural environment. Therefore, an environmental impact assessment, both short-term and long-term in scope, should be made of any major development scheme as a basis for drawing up strategies for minimizing undesirable impacts. Although a number of techniques are available for such impact assessment, the checklist and matrix approaches appear to be the most suitable for use in Southeast Asia, where impact studies are only just beginning to be introduced.

For balancing the conflicting pursuit of Man's goal of 'maximum production' with the desired 'maximum protection' of the environment, two possible solutions, namely continual compromise and the compartmentalization approach, look appropriate for Southeast Asia. Where there is still a possibility of choice in determining land-use, the compartmentalization approach is recommended.

(Enviromental Conservation, 7, 3 (Autumn 1980) pp. 213-16)

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Non-radiological Environmental Implications of Nuclear Energy

By Asit K. Biswas

(Summary)

Discussions on environmental implications of nuclear energy have so far been concentrated on radiological aspects; disposal of radioactive wastes, safety of nuclear power production, safe handling of plutonium, and problems associated with uranium mining. There are, however, several environmental issues associated with nuclear power production that are non-radiological in nature; thermal pollution and attendant effects on aquatic life, problems associated with land-use requirements, aesthetic considerations, habitat alterations, and atmospheric effects. These different non-radiological environmental implications of nuclear energy are reviewed.

The paper concludes that, while there are some environmental problems which exist at present, and a few more could emerge in the future, all these problems appear to be solvable with the present state of technological development. The extent of environmental degradation can be significantly reduced by appropriate design and planning.

(Environmental Conservation, 7, 3 (Autumn 1980) pp. 229-37)

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Environmental Problems, Development, and Agricultural Production Systems
By W.B. Clapham, Jr.
(Abstract)

This paper examines the role of the environment in the context of the overall agricultural production system. It suggests that this circumstance of agriculture representing 'the conscious maintenance of artificial and unstable ecosystems' provides an effective and straightforward mechanism for assessing the significance of environmental problems of agriculture. At the same time it aids in setting priorities for understanding the component processes of the environmental problems of agriculture and in collecting data for their detailed observation.

(Environmental Conservation, 7, 2 (Summer 1980) pp. 145-52)

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The timing of pest control operations in relation to secondary poisoning prevention
By Yoram Yom-Tov
(Abstract)

The use of intensive, irrigated agriculture causes an explosion in the population of some wild animals, especially in desert and semi-desert areas. Control operations might cause considerable damage to non-target organisms, including raptors.

A case of control operation on a chuckar partridge population in semi-desert area in Israel, without harming non-target organisms, is reported here. The timing of the operation and the significance of familiarity with the pest behaviour and their predators' annual cycle is essential for the success of such an operation.

(Biological Conservation, 18, 2, (Aug. 1980) pp. 143-47)

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Pain Responses in Nepalese Porters

By W.C. Clark and S.B. Clark

(Abstract)

When tested by the method of limits, Nepalese had much higher pain thresholds to electrical stimulation than Occidentals did. Discriminability was the same for both groups, however, indicating that there were no neurosensory differences. Nepalese had higher (stoical) criteria for reporting pain but were not less sensitive to noxious stimulation. The battery of sensory measurement procedures described may be applied to any modality and are particulary applicable to difficult field conditions.

(Science, 209, 4454 (July 18, 1980) pp. 410-12)

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What we don't know about pain
By P.D. Wall and C.J. Wolf

A recent article in these columns' by Chung and Dickenson discusses the relationship between pain, the enkephalins and acupuncture. We are told that "placing a single needle into a certain point of the body can produce... a potent amelioration of pain". It is proposed that acupuncture analgesia acts by the release of endogenous opioids within the brain and that these enkephalins indirectly stop "pain cells" in the spinal cord from transmitting their messages. How one wishes all this were true. If it were so, we would be well on our way to understanding and controlling the chronic pain states which continue to plague so many. We would like to supplement Chung and Dickenson by examining whether acupuncture does produce pain relief, what evidence there is for a role for the endogenous opiods in modifying nociceptive transmission and how the nervous system is organized to transmit and process information about noxious stimuli.

After 2,000 years of continuous use in China and some 350 years of intermittent Western enthusiasm, we still await controlled clinical trials which conclude that acupuncture is effective in treating chronic pain. Innumerable, uncontrolled and anecdotal reports exist. Such 'trials' report success rates of up to 94% but in a controlled trial at the University of Washington Pain Clinic, none of a 100 patients showed any objective benefit after three weeks of acupuncture therapy. Another controlled trial found that acupuncture does produce a very transient analgesia, but that this analgesia occurs equally with 'sham-acupuncture' and with needling of the traditional meridian points. For acute pain, we read of the successful application in China of acupuncture in half a million operations, but this does not match the experience of an invited team of western experts, who witnessed operations on highly selected patients, only a small fraction of whom had pain free operations with needles alone. Moreover the use of acupuncture for surgery in China is reported to be steadily declining. There is no doubt that powerful analgesia with acupuncture does occur and has to be explained. Unfortunately, it is a rare phenomenon and for the huge majority of patients the needle is a blunt tool. Evidently acupuncture, when it works, acts by some mechanism which does not always operate in the majority of people, unlike the uniform ability to react to narcotic analgesics.

All sensory stimuli interact with each other producing distraction, jamming and specific local and distant interactions, Many have selected special examples of this general phenomenon and called them 'experimental acupuncture' although they usually bore no relationship to traditional acupuncture practice. In healthy volunteers, needling or electrical stimulation can produce a mild rise in the threshold for certain painful stimuli. This antinociceptive effect is most marked in the region of the painful stimulus and not at a distance or at 'meridians' as predicted by classical acupuncture. The analgesia produced by such experimental acupuncture is quite feeble and unlikely to be clinically useful, and must not be confused with the rare cases of perfect surgical analgesia

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produced by acupuncture or with the use of segmental transcutaneous electrical stimuli which have a highly satisfactory effect on certain types of hyperalgesias with minimal effects on cutaneous pain thresholds.

There is no doubt that the enkephalins and a number of other opioid peptides are highly concentrated in specific regions within the brain and spinal cord, but their role, if any, in pain remains an enigma. One attempt to study this problem has been to investigate the effect of naloxone, an opiate receptor antagonist, on a variety of different pain states and analgesic procedures. Naloxone completely reverses the analgesic effects of administered narcotics. If the endogenous opioids were active in normal men or animals one would expect that naloxone would antagonize their action and consequently produce pain or a drop in pain thresholds. Most studies in man have shown that naloxone has no effect, while in animals naloxone has been found to produce hyperalgesia, analgesia, and no change, in the response to noxious stimuli. Patients suffering from chronic pain are unaffected by naloxone although one might expect these patients to be mobilizing whatever anti-pain resources they possess.

Naloxone has been reported to produce a partial reduction both of experimental acupuncture analgesia in man, and of the analgesia produced by midbrain electrical stimulation, but these results need to be confirmed since conflicting reports are found in animal studies. There is evidence in the rat that local segmental interactions between sensory inputs in the spinal cord are modified by naloxone but it will be difficult to determine whether similar changes occur in man. Recently, in fascinating but highly controversial work, Levine & Fields report that very high doses of naloxone abolish the placebo reaction, suggesting that the 'analgesia' resulting from blank injections may be produced by the mobilization of endogenous opioids.

Whatever function the opiods do perform in pain, it is unlikely to be simple as indicated by the growing list of endogenous peptide compounds with opioid activity and the subdivision of the opiate receptors into numerous functional categories. One of the problems in interpreting studies using naloxone is that it has a greater affinity for some classes of opiate receptors than for others. Nevertheless it is clear that there is no evidence for an internal narcotic dispensing system in the brain automatically controlling the intensity of perceived pain.

In their summary of the anatomy and physiology of the pathways which bring news of injury to the brain, Chung and Dickenson use the most classical model for simplicity and brevity. They refer to pain fibres and pain cells in peripheral nerves and spinal cord as though there is a specialised chain of nerve cells which leads inevitably from the fact of injury to the sensory experience of pain. They further isolate this 'pain system' by saying that "in stark contrast to the other senses it is characterised by elaborate feedback networks" which "ensure that it is fail-safe" and "which, when activiated, reduces the intensity of persistent pain". This approach "which implies a distinct anatomical and physiological pain system separate from other sensory systems" represents a definite philosophy which would

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shape future experiments and have considerable therapeutic implications if true. For example, given a distinct anatomy such as the pain cells described and a distinct feed back control such as the raphe nucleus and distinct chemistry such as the enkephalins, one might reasonably hope to achieve pain control with no influence on other aspects of feeling or behaviour. The concept of a separate pain system originates in our own introspective certainty that pain itself is a clearly discrete category of experience which we are convinced implies injury. Therefore we are also convinced that we must possess an isolated private alarm system which inevitably links injury to pain. The failure of this concept to explain the observed clinical and experimental facts has been discussed extensively and led to the gate control theory and its extensions. Chung and Dickenson use gate theory as though it applied only to a 'pain system'. An acceptable pain theory would have to incorporate an explanation of at least the following clinical facts: (1) the bizarre coupling of the amount of injury to the amount of pain, (2) the triggering of pain by innocuous stimuli to normal tissue (tenderness, referred pain and trigeminal neuralgia), (3) the sensation of pain in missing limbs, (phantom pain), (4) the failure of narcotics to influence some pains, (brachial plexus avulsions), (5) the success and failure of the various counterstimulation methods (acupuncture, transcutaneous stimulation).

Undoubtedly for lack of space Chung and Dickenson have concentrated on only one particular 'pain' inhibitory system, which is said to operate via noxious inputs and the nucleus raphe magnus to modify the actvity of spinal cord nociceptive cells. However, as Chung and Dickenson point out this is only one example of many such inhibitory systems. The brain has many reasons, tactics and strategies for selecting and modifying the incoming information it receives. Each of the different neural systems responsible for such 'controls' offers explanations for particular pain states, and opportunities for therapy. Some of the control systems are located in the spinal cord. For example, stimulation of large low threshold sensory fibres produces a striking inhibition of the response of spinal cord cells to peripheral injury. Other control systems act via the brain and there is good reason to suspect that some of these inhibitory effects are mediated by the small cells of the substantia gelatinosa. Therefore the activity of all nociceptive cells is controlled by a balance of excitatory and inhibitory mechanisms mediated by many neural circuits, some local within the spinal cord and some with long axes extending from cord to brain.

Experimental investigations of the functional profiles of neurones responding to noxious inputs and of their 'controlling' influences have been performed either in isolated parts of the nervous system such as the spinal cord or in highly unphysiological preparations such as anaesthetized or decerebrate animals. These experimental preparations represent a study of the nervous system locked at one extreme of its functional repertoire. While defining limits is a responsible scientific pusuit, it is difficult to establish the validity of these data in speculating about the operation of the system in the behaving organism. Having studied the functional reportoire of cells in these antificial states, it is clearly necessary to return to a study of their behaviour in the intact behaving organism before we can label cells as 'pain' cells. We are a long way from that step. How best to approach it? One way is to return to the animal and human patient to define

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the input-output nature of their problems rather than to force them to conform with ancient theory of how they ought to behave. We are emerging from a necessary era of physiology in which attention was concentrated on sudden stimuli and the consequent surge of impulses which ran through the nervous system over the subsequent 100 milliseconds. These volleys are travelling over neural circuits whose transmitting qualities have been set by much slower processes. These began in the embryo and obviously depend on a relatively fixed anatomy but it is now becoming apparent that there are also plastic physiological and biochemical processes which shape the responsiveness of nerve cells. It may well be that the huge newly discovered family of peptides including the enkephalins and endorphins have more to do with setting the mode of operation of the nervous system's analysis mechanisms than with the incoming messages which are to be analysed.

Chung and Dickenson comment: There are two separate issues concerning acupuncture. First, we must ask if acupuncture analgesia is a reproducible phenomenon that can be studied in the laboratory. This question can be evaluated as we have done, from published studies. Second, we must ask if acupuncture is clinically effective. This is more difficult to assess, as there are numerous claims and counter-claims and the arguments are generally construed by carefully selecting one set of reports from the 'western experts' and dismissing the results which do not conform with preconceived opinions. We feel that controversy at present over the validity of clinical data is unproductive. Except for a brief mention that stimulation described by the experimenters as 'acupuncture-like' (as distinct from transcutaneous electrical stimulation) appears to be especially effective in relieving chronic pain in man, we avoided this issue in our review. There are however, many studies demonstrating that electroacupuncture and similar manoeuvres in animals enhance the threshold to pain and influence the responsiveness of pain cells. For example, cells responding steadily to painful stimuli are silenced when "acupuncture-like electrical stimuli" are delivered elsewhere on the body. How the reduced activity of these cells is related to the subjective intensity of pain is unknown, as are the precise neural mechanisms by which such an inhibitory influence is brought about. Regardless of its ultimate clinical usefulness, the phenomenon deserves further investigation, and much of the current research into pain is indeed aimed at elucidating the mechanisms mediating inhibitory influences.

As Wall and Woolf point out, the involvement of opioids in modulating pain is not fully understood and conflicting evidence exists. It is likely that the role of opiates or endogenous peptides in the perception of pain will turn out to be complex. Of the many levels of the central nervous system at which pain transmission can be modulated, the raphe-spinal system

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appears to exert the most powerful inhibitory effects. We concentrated on this system mainly because the evidence for its inhibitory role is least controversial. Opiates, central electrical stimulation, acupuncture and, more recently, transcutaneous nerve stimulation have been claimed to act to some extent via this nucleus in producing their analgesic effects.

We have not stated, nor implied, that the pain system is isolated from "feelings ... and behaviour" or from other sensory systems. There are chains of cells which respond preferentially, and often solely and exclusively, to what the experimenter would consider to be noxious stimuli. These are usually referred to as 'cells which are involved in transmitting nociceptive messages', but to avoid circumlocution, we called them 'pain cells'.

(Nature, 287, 5779 (Sept. 18, 1980) pp. 185-86)

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How Good Are the Top-Selling Drugs?
T. Donald Rucker (Ohio State Univ.) In American Journal of Hospital Pharmacy 37(6):833-7, Jun 80

..."The 200 drug preparations most frequently dispensed in community pharmacies, covering 163 separate drug entities, were rated for therapeutic acceptability by using 10 independent indicators, five of positive opinion and five of negative opinion. Less than 47% of the drug entities satisfied the criterion of clinical superiority. At least 25% apparently should be excluded altogether as drugs of choice."

(Source: Current Contents - Life Sciences, 23, 40 (October 6, 1980) p. 19)

Federal Policies Affecting Vaccine Research and Production

By Michael A. Riddiough and Jane Sisk Willems

(Summary)

The limits to antibiotic treatment of infectious diseases are now well established. Pneumococcal infections, for example, have been treated with penicillin for about 30 years. In a study by Austrian, however, it was found that even with the best of antibiotic therapy 17 to 30 percent of high-risk patients with pneumococcal pneumonia accompanied by documented bacteremia died. Further, bacterial resistance to antibiotics is mounting.

Public policy-makers appear to be reevaluating the merits of disease prevention and health promotion, especially since the cost of disease treatment has escalated dramatically during the past decade.

The use of safe and efficacious vaccines have proved to be a cost-effective method of preventing certain childhood diseases in this country; polio is the most notable example. A strong commitment of the private sector to vaccine research, development, and production appears to be essential to the creation of new vaccines and to the continued supply of currently available vaccines. Because federal policies greatly affect that commitment, which now appears to be waning, a review of federal vaccine and immunization policies appears to be needed.

(Science, 209, 4456 (Aug. 1, 1980) pp. 563-66)

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Sources of Continental Crust: Neodymium Isotope Evidence from the Sierra Nevada and Peninsular Ranges

By Donald J. De Paolo

(Abstract)

Granitic rocks from batholiths of the Sierra Nevada and Peninsular Ranges exhibit initial $^{143}Nd/^{144}Nd$ ratios that vary over a large range and correlate with $^{87}Sr/^{86}Sr$ rations. The data suggest that the batholiths represent mixtures of materials derived from (i) chemically depleted mantle identical to the source of island arcs and (ii) old continental crust, probably sediments or metasediments with a provenance age of 1.0×10 years. These conclusions are consistent with a model for continental growth whereby new crustal additions are repeatedly extracted from the same limited volume of the upper mantle, which has consequently become depleted in elements that are enriched in the crust. There is little evidence that hydrothermally altered, subducted oceanic crust is a primary source of the magmas.

(Science, 209, 4457(Aug. 8, 1980) pp. 684-87)

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IDRC's Approach to Science and Technology for Development

By Michelle Hibler

(Summary)

Canada's International Development Research Centre (IDRC) is an independent public corporation established to aid scientific research in developing countries. In supporting 649 projects in 100 countries, it has earned an enviable international reputation and has been used as a model for other aid agencies. Now entering its tenth year, IDRC is reaffirming its policies of responsiveness to the stated needs of developing countries and of strengthening their scientific and technological capabilities. It also seeks to encourage the application of Canadian R & D expertise to the solution of Third World problems.

(Science, 209, 4454 (July 18, 1980) pp. 362-67)

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A Technique for Expressing Eukaryotic Genes in Bacteria

By Leonard Guarente et al.

(Summary)

Methods are described that allow efficient expression in Escherichia coli of cloned eukaryotic genes. The methods require that the coding sequence of the gene in question be available in a form uninterrupted by intervening sequences (for example, as a complementary DNA clone). The gene products are synthesized unfused to other amino acid sequences. The genetic manipulations are simple, and require the plasmids described and commercially available enzymes.

(Science, 209, 4463 (Sept. 19, 1980) pp. 1428-430)

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Human Gene Treatment Stirs New Debate

By G.B. Kolata and N. Wade

(Extracts)

Public sensitivity to the subject of human genetic manipulation underlies the intense interest aroused by the news on 8 October of the gene therapy now being applied to two patients suffering from thalassemia. The treatment, devised by a team of researchers at the University of California, Los Angeles, is the first known occasion on which the technique of recombinant DNA or gene splicing has been applied to humans.

...The UCLA gene therapy is part of a plan, first conceived in 1978, which its originators hope will lead to a viable treatment of sickle cell anemia, a serious disease among black Americans. The UCLA team decided first to develop a treatment for beta-zero thalassemia, a disease in which the failure or success of the therapy would be easier to monitor...

...The protocol for the gene therapy calls for production of both the human beta-hemoglobin gene and the virus enzyme gene by cloning copies of each in bacteria. Marrow cells taken from the patient are then exposed to the two genes in a way that encourages the genes to enter and become part of them. The cells are then injected back into the patient. Under the conditions of the UCLA protocol, probably 10,000 or so of the injected cells may contain both genes. In theory, only one cell need settle and proliferate in the marrow to give the patient useful quantities of normal hemoglobin.

Why did the UCLA team proceed without the endorsement of the university's Human Subjects Use Committee? The researchers applied in parallel for permission to conduct the experiment both in Los Angeles and abroad, at the Hadassah hospital in Jerusalem and at the University Poly Clinic in Naples. Both institutions gave their assent, and the therapy was started, before the UCLA committee made up its mind that there should be another round of tests, in monkeys, before going to humans.

Albert Barker, a UCLA vice chancellor who oversees the Human Subjects Use Committee, says that the committee deliberated long and hard over the team's proposal and called upon a number of outside reviewers. It eventually decided that the chances of successful gene transfers in humans would be enhanced by additional animal experiments, but the committee will not elaborate. However, researchers in the field suggest trying to transfer globin genes in animals to prove that such a gene transfer can, in fact, be done successfully. As to the risk of the human experiments, Barber says that, on the basis of animal work done so far, they do seem low.

The UCLA team published its preliminary experiments on animals in April this year. The researchers did not inform the NIH or the University public relations office of the gene therapy trials, hoping that secrecy would be maintained until the experiment had been reported in the scientific literature.

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It was agreed that none of the team would talk to the press, an arrangement that dissolved when the Los Angeles Times picked up the story last week. The NIH, a month ahead of the newspaper, asked on 8 September for a full account of the experiment, including whether it had been approved by human subjects committees and whether federal funds were involved...

...The research team intends ultimately to develop a treatment for sickle cell anemia. The disease is much harder to treat than beta-zero thalassemia because a majority of marrow cells must be replaced before the patient experiences any benefit.

The concept pursued by the UCLA team was originally developed in conversations between Winston Salser, Martin Cline, and Howard Stang.

(Science, 210, 4468 (Oct. 24, 1980) p. 407)

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Gene Splicer Goes Public

The gene tailoring company Genentech has announced plans to go public next month, the first of the new genetic engineering companies to do so.

Founded in 1976 by Robert Swanson, and by Herbert Boyer of the University of California, San Francisco, Genentech now employs a staff of 126, including 40 Ph.D.'s. It is not yet a gold mine. In the first 6 months of this year the company earned $3.5 million. But Genentech officials say they expect the million shares to be offered to the public next month to sell for $25 to $30 each.

The basis for this unusual price-to-earnings ratio is Genentech's hope of substantial revenues after its products reach the market. The three major recombinant DNA-made products so far announced are interferon, under contract to Hoffmann-La Roche, insulin, prepared for Eli Lilly, and growth hormone, made for Kabi.

A possible cloud overhanging the interferon project is a claim against Genentech's partner Hoffmann-La Roche by the University of California. The prospectus issued by Genentech says only that there exists a claim against Roche which, if a law suit is filed, could be expanded to Genentech. But in that event, the prospectus continues, there would be no effect on Genentech's earnings because Roche has agreed to protect Genentech against loss.

The claim concerns a cell line developed by H. Phillip Koeffer and David W. Golde of the University of California, Los Angeles, in 1978. The interest of the cell line is that it produces interferon, the wonder substance hoped, but not yet proved, to be of relevance to the treatment of cancer.

Both Golde and Koeffer, under instructions from their attorney, refuse to discuss the claim against Roche, and Roche officials stick tight-lipped to a statement that they "acted properly with regard to the cell line," which the company obtained from the National Cancer Institute. The dispute seems to center around the terms under which the cell line was received by Roche.

Genentech is going public earlier than generally expected. An investment analyst who follows the gene splicing industry. Nelson Schneider of E.F. Hutton, said only in May that "None of these companies has any thought of going public and if they were we would tell them not to because there is no guarantee as yet that this technology will produce anything."

Now is an appropriate time for Genentech to go public, says vice president Thomas D. Kiley; it has shown it can make useful products and needs money to build a manufacturing plant. Public, not private, capital is being sought "because we want to maintain our independence and freedom of action," says Kiley, - N.W.

(Science, 209, 4461(Sept. 5, 1980) p..1102)

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Combination chemoprevention of cancer
By Michael B. Sporn

The current use of cytotoxic drugs for treatment of invasive cancer in man depends largely on combination chemotherapy - the combined use of several drugs which exert synergistic effects to achieve the goal of total tumour cell kill. Several papers presented at a recent meeting suggest that for similar reasons 'combination chemoprevention' might be of importance in the future development of non-cytotoxic drugs for prevention of cancer, that is, for the arrest or reversal of the development of neoplasia in its premalignant stages. Recent advances in the understanding and control of tumour progression (Promotion) have been particularly striking. Using the classical two stage model of mouse skin carcinogenesis (the hydrocarbon, DMBA, as initiator, and the phorbol ester, TPA, as promoter), A.K. Verma and R.K. Boutwell (University of Wisconsin) reported that the combinations of either retinoic acid plus the steroid, dexamethasone, or retinoic acid plus the protease inhibitor, TLCK, exert marked synergistic preventive effects. Their results suggest that retinoic acid, dexamethasone, and TLCK inhibit skin tumour promotion by independent mechanisms. Similar conclusions were reached recently by T.J. Slaga et al. (Oak Ridge National Laboratory; Proc. natn. Acad. Sci. U.S.A. 77, 2251; 1980) who have shown that the promotion stage in this system can be further divided into two stages, with the first stage caused by limited application of TPA, and the second caused by the related weak diterpene promoter, mezerein. Slaga et al. suggest that low doses of TPA induce formation of primitive skin stem cells, while mezerein induces formation of polyamines and resultant cell proliferation. The TPA effect can be blocked by the protease inhibitor, TPCK, while the mezerein effect is blocked by retinoic acid; glucocorticoids apparently inhibit both stages of promotion. In other studies, Verma, Ashendel, and Boutwell (Cancer Res. 40, 308; 1980) have shown that retinoic acid and indomethacin, an inhibitor of prostaglandin synthesis, exert a synergistic effect to block the induction of ornithine decarboxylase (ODC) caused by TPA; ODC activity has been previously implicated as a key step in formation of polyamines. Whether retinoids and inhibitors of of prostaglandin synthesis are synergistic for prevention of skin tumours in the mouse is currently being studied.

Another important area for studies of initiation and promotion is mammary carcinogenesis, in which the internal hormonal milieu of the organism is believed to provide the required promotional stimulus for development of cancer. In the female rat, one or two doses of the alkylating carcinogen, nitrosomethylurea,

Contd.--35/-

suffice to initiate carcinogenesis. In new studies, C.W. Welsh (Michigan State University) and R.C. Moon (IIT Research Institute) reported that the combined use of a suppressor of prolactin secretion (2 - bromo-α-ergocryptine) together with the retinoid, retinyl acetate, was distinctly superior to either treatment alone in preventing mammary cancer after rats were treated with the carcinogen. Prolactin has long been suspected as a promoting agent in human mammary carcinogenesis, and suppression of its secretion has an obvious rationale. The molecular mechanism of action of the retinoids in this system is not known, although it has been shown (Moon et al. Cancer Res. 39, 1339; 1979) that they have an anti-proliferative effect on mammary epithelium.

Combination chemoprevention also is applicable to inhibition of the initiation of cancer, as was reported by P.W. Dion, W.R. Bruce et al. (Ontario Cancer Institute). It had previously been shown by Bruce's group that mutagenic substances (assayed by the Ames test) are found in human faecal material, and they have been suggested as possible endogenous causative agents for colon cancer. Since it is suspected that these mutagenic substances may be N-nitroso derivatives of intestinal lipids, Bruce et al. have fed ascorbic acid and α-tocopherol (Known inhibitors of nitrosamine formation) to human volunteers. They reported that the combination of ascorbic acid and tocopherol reduced the median level of faecal mutagen to 25% of control values; the rationale for the combination is to achieve an effective level of anti-oxidant in both the aqueous and hydrophobic phases of of the intestinal contents. Another important observation relating to ascorbic acid and cancer prevention was reported by W.F. Benedict and P.A. Jones (University of Southern California), who have shown that levels of ascorbic acid as low as 1 ug per ml can inhibit malignant transformation of mouse fibroblasts caused by methylcholanthrene in cell culture. They found that ascorbic acid was effective in blocking transformation when given as late as 3 weeks after exposure of cells to the carcinogen. Previously, ascorbic acid had been considered to be of chemopreventive use only as an anti-initiating agent. Benedict and Jones' new studies (see also Cancer Res. 40, 2796; 1980) suggest that ascorbic acid may also function as an anti-promoting agent, and will undoubtedly add further interest to the already controversial area of the use of this compound in treatment and prevention of malignancy.

Whatever may be the outcome of these studies, the field of combination chemoprevention appears to be developing rapidly.

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In other areas of pharmacology the use of multiple drugs to achieve synergistic action and to diminish toxicity is well established. At present, it cannot be predicted how successful such methods might be for applied chemoprevention in man. However, as interest in pharmacological prevention of cancer increases (and as concern about the possible toxic effects of some of the preventive agents, particularly the retinoids, also increases), combination chemoprevention will undoubtedly attract further attention.

(Nature, 287, 5778 (Sept. 11, 1980) pp. 107-08)

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Cloned Antibodies Promise Medical Revolution
Harold M. Schmeck, Jr. in New York Times 5 Aug 80

..."Revolutionary changes in understanding and treatment of disease, development of vaccines and other advances appear to be in prospect because of a technique for producing antibodies that is coming into laboratory use throughout the world. The antibodies called monoclonal because each type is produced by a single clone of cells, are extraordinarily pure, uniform and reproducible. Such antibodies, produced from mouse cells, are already having a major impact on the science of immunology. Specialists expect even further impact because of success...in making these antibodies from human cells."

(Source: Current Contents - Life Sciences, 23, 42 (October 20, 1980) p. 15)

Interferon production
Japan now

International agreements for the manufacture of interferon appear to be catching on. Last week, the Wellcome Foundation Limited (whose sole shareholder is the British foundation known as the Wellcome Trust) announced an agreement with the Sumitomo Chemical Company of Japan that will in due course enable the Japanese company to use [illegible] technology for manufacturing lymphoblastoid interferon.

The project, which is thought to be potentially worth several million pounds to the British company, will first of all involve clinical trials in Japan based on interferon supplied by Wellcome. Thereafter, the Japanese company will decide whether or not to go ahead with the building of a plant for producing interferon commercially, using the techniques developed at the Wellcome Foundation over the past few years.

Broadly speaking, the technique is to infect a culture of lymphoblastoid cells with Sendai virus, which stimulates interferon production, and to extract lymphoblastoid interferon on chromatography columns loaded with antibodies against the type of interferon being produced.

So far there has been no opportunity to decide whether the recently announced technique for raising monoclonal antibodies against interferon (Secher, D.S. and Burke, D.C., Nature, 285, 446; 1980) will make this process efficient.

The cost of interferon plants of this kind is likely to be of the order of £5 million. It is thought that the production of interferon by the Wellcome Foundation now exceeds the total production of Finland, hitherto the chief source of interferon. For those drug houses manufacturing interferon from tissue cultures, the overriding question for the future must be whether cloning techniques will lead to more efficient and cheaper manufacture.

If it is possible to obtain as many as a hundred molecules of interferon from a bacterium such as Escherichia coli carrying an interferon gene, the capital costs of the manufacturing plants required to produce a given amount of interferon will be reduced at least in proportion to the ratio of the generation times of bacteria and cells in culture - 20 minutes to three days or a factor of a hundred. Drug houses using tissue culture techniques (which are thought to include Roche and Merck as well as Wellcome)

Contd ---30/-

appear however to be counting on the length of the period of clinical investigation of cloned interferon that would be needed before these could be put on the market.

As things are, there is no direct evidence that cloned interferon is equivalent to that from tissue culture and in any case the multiplicity of interferon molecules now being identified will need to be distinguished from each other physiologically and clinically, a process thought by the existing manufacturers to require five years or so.

Although the agreement with the Sumitomo Chemical Company has been formally signed, there are some grounds for anxiety that the agreement may be frustrated by difficulties in Japan about the widespread use of whatever materials the Wellcome Foundation's Japanese partner eventually seeks to put on the market.

(Nature, 286, 5775(Aug. 21, 1980) p. 751)

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Basic Research in the US

Philip Handler (National Academy of Sciences, Washington, DC) in Grants Magazine 3(2): 72-82, Jun 80

..."This country never made an explicit decision that the university should be the primary locus for the conduct of basic research. That it became such was the consequence of a multitude of lesser decisions, while, in parallel, industry reduced the fraction of its own resources that it allocated for basic research in-house. In any case, universities now conduct perhaps three-quarters of all basic research. But, because universities are organized and budgeted primarily to discharge their formal educational obligations, the academic research endeavor is remarkable in that (i) the number of potential investigators is a function of the size of the teaching faculty, and (ii) because the labor force for this enterprise consists of individuals who think of themselves as graduate students and postdoctoral fellows, their stipends are modest compared to their contributions, and the entire enterprise is funded 'on the cheap.' "

(Source: Current Contents - Life Sciences, 23, 41, October 13, 1980) p. 15)

Interferon studies disappointing so far

Interferon's potential as a cancer cure may be proved eventually, but results so far have been less than fantastic. On the positive side, Hans Strander and colleagues of the Karolinska Hospital in Stockholm report that six of twelve patients with osteogenic sarcomas who were treated with interferon are now free of detectable cancer. Less optimistic results come from U.S. clinical trials.

At a meeting of the American Association for Cancer Research in San Diego last week, E.F. Osserman of Columbia University College of Physicians and Surgeons reported on preliminary results from a clinical trial that he and his colleagues set up under the auspices of the American Cancer Society (SN: 10/28/78, p.295). Fourteen patients with multiple myeloma who had never before been treated for their cancer or who were in relapse after drug therapy received interferon daily for six months (unless their cancer was clearly progressing). To date, only four of the 14 have experienced substantial regression of their cancers. With drug therapy, Osserman says, cancer regression would have been expected in 11 out of 14 patients.

Also at the AACR meeting, tentative results of the ACS interferon trial against breast cancer were presented. Patient eligibility was limited to women with objectively measurable breast cancers who had not received prior therapy. To date, 16 breast cancer patients have been treated with interferon from 42 to 84 days, and only five have responded.

Still a third batch of preliminary results was presented at the AACR meeting by Susan Krown of the Memorial Sloan Kettering Cancer Centre in New York City. Krown and her colleagues gave interferon to 16 lung cancer patients for 30 days. All but two had been treated previously with drug therapy. So far only 15 of the 16 patients have proved evaluable, and of the 15, eight have not changed, and seven have actually grown worse.

Nonetheless, the researchers participating in the interferon trials are encouraged that interferon has shown at least some anticancer activity. And as Frank J. Rauscher Jr., vice president for research at the ACS, points out, "The activity we have found warrants further testing and more precise, longer-term studies to find out how permanent are interferon's effects, exactly how it works, what are its side effects and what the optimum dosage should be."

(Science News, 117, 23 (June 7, 1980) p. 358)

The implications of a widespread conversion to biomass-based fuels - Social Impacts

By Arthur A. Few, Jr

(Extract)

The long-term answer lies in the utilization of fuels that are renewable at a fixed sustained rate. Biomass fuels have all of the proper attributes for the ideal fuel for the future:

- Biomass fuels have a global distribution that reflects the population distribution; it is an extensive as opposed to intensive energy source.
- Biomass fuels are renewable.
- Biomass fuels utilize lower technology and require a dispersed labour force.
- Biomass fuels are nonpolluting.
- Biomass fuel economics can promote an increase in the global biomass reserve, and ameliorate the atmospheric CO_2 trends.
- Increased biomass production causes shifts in local climatology toward more humid conditions; reclamation of lands lost to deserts may be possible.
- Biomass fuel economics can allow the smaller landowners to hold onto and return to the land.
- Biomass fuel economics can lead to a stable noninflationary world economy.

Most important, the widespread use of biomass-based energy can lead to a value system that is related directly to land use, soil characteristics, water resources, and informed management; the rewards of this value system would go to those practicing wise stewardship of these resources.

(Science & public policy, 7, 4 (August 1980) pp. 264-75)

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Radioactive Waste: The Problem of Plutonium

By Hartmut Krugmann

Abstract. Systems under development for the recovery of plutonium from spent fuel and its recycling in fresh fuel would not significantly reduce either the total radioactivity or the amount of fissile plutonium in radioactive waste relative to what is possible with once-through fuel cycles.

(Extracts)

In April 1977, as a result of increasing concerns that the recovery and recycling of plutonium from "spent" nuclear reactor fuel could ease its diversion to weapons uses, the U.S. government deferred plans for the commercialization of plutonium recycling technologies and urged other governments to do likewise until alternative, possibly more proliferation-resistant nuclear fuel cycles had been examined...

...Reductions in the plutonium and overall transuranic content of radioactive wastes comparable to those that are achieved in the standard plutonium recycling systems can be accomplished with refined once-through fuel cycles. These findings apply to the plutonium recycling technology that has been developed to date. Further technology might reduce the quantities of plutonium and other transuranic elements in the radioactive waste streams from recycle systems to levels well below those achievable with once-through systems. The plutonium in recycle systems passes through so much plumbing and machinery, however, and goes through so many changes in chemical and physical state that reducing losses by a large amount may well be quite costly. Furthermore, the transmutation of the average higher transuranic atom into shorter-lived fission products in reactors would take many cycles. Even with no leakage, it would take 100 years of very careful recycling in a breeder reactor to destroy 90 percent of the neptunium, americium, and curium that would otherwise go into the reprocessing wastes.

(Science, 210, 4467 (Oct., 17, 1980) pp. 319-20)

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Artificial splitting of water by sunlight only two years away
By Nigel Henbest

The artificial disintegration of water by sunlight to produce energy has come another couple of steps closer to reality. Melvin Calvin in the US has reported that commercially-important compounds could be made by artificial photosynthesis; while Sir George Porter, director of the Royal Institution in London, predicts that the production of hydrogen from water by purely chemical means will be achieved within two years.

Calvin, of the University of California at Berkeley, has been investigating photosynthesis for 45 years, and won the Nobel Chemistry prize in 1961 for his work on the later stages of the process. Recently he has been trying to mimic photosynthesis artificially, using artificial metal complexes in a hollow spherical membrane in place of a plant cell's chlorophyll-containing chloroplast.

Natural photosynthesis involves two light-absorbing processes. Photosystem II splits water, by extracting electrons from the water molecule. This leaves the hydrogen atoms in solution as positively-charged ions, while releasing the oxygen as molecules to the atmosphere. The electrons pass to photosystem I, where they reduce the compound NADP (nicotinamide adenine dinucleotide phosphate) to NADPH2; the latter then provides the energy to convert carbon dioxide to sugars.

Artificial systems dispense with the last step. They use the compounds reduced by photosystem I (substitutes for NADPH2) to convert the hydrogen ions in solution to hydrogen gas. The net result is to split water into oxygen and hydrogen - the latter being valuable as a non-polluting energy source (New Scientist, 10 April 1980, p 72). Calvin's latest achievement differs both from this goal and from natural photosynthesis. He has trapped the oxygen atoms produced by the first step, photosystem II, and intends to use them as a strong oxidising agent.

The oxygen atoms are trapped by manganese atoms before they can combine to form oxygen molecules. Among the commercial applications of an oxidising agent produced purely by sunlight is the conversion of propylene - an ingredient of natural gas - to propylene oxide. This is a versatile compound for plastics manufacture: US firms alone convert some 4000 million tonnes per year into film, fibres and foam plastics.

Calvin announced his results at the Third International Conference on Photochemical Conversion and Storage of Solar Energy, held at Boulder, Colorado. Despite the claims, though, his system is not complete. The electrons from the oxygen-producing photosystem II must be absorbed by an electron-acceptor; a different electron-donor must supply electrons to the hydrogen-producing side photosystem I. At present these substances must be added; and they are used up as the reaction proceeds. Calvin is optimistic about finding the necessary mechanism to mimic the natural process by which electrons are handed directly from photosystem II to photosystem I.

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But he may not be the first to achieve this goal. Other groups are equally far advanced in their different lines of research. Unlike Calvin, most of them see their aim as the production of hydrogen gas; but the goal for all is to convert sunlight into useful forms of energy by the catalytic photochemical splitting of water - without having to add electron acceptors or donors. No one has yet achieved a purely catalytic reaction that will run indefinitely on a supply of sunlight and water alone. Some groups, like Calvin's, are mimicing natural photosynthesis, while others prefer to take a purely artificial approach.

Among the latter is Michael Gratzel, of the Ecole Polytechnique at Lausanne. He optimistically predicts that when water can be efficiently split by photochemical catalysis "the world's energy problem's will be solved" - quite apart from the Nobel prizes to be picked up. Calvin's trapping of oxygen may in fact help the hydrogen-producers, for free oxygen poisons many of the reactions in the photochemical train.

Sir George Porter, a leading expert in photolysis, heads the Royal Institution group which is also investigating the purely chemical splitting of water into hydrogen and oxygen. He told New Scientist that the subject has "moved much faster in the past year than expected". He sees the breakthrough coming within two years in the laboratory, and envisages no major problems in then scaling up the system to the commercial production of hydrogen.

(New Scientist, 87, 1215 (Aug. 21, 1980) p. 585)

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Observation of flaws in anodic films on aluminium
By G.E. Thompson et al.
(Abstract)

A thin compact oxide film forms naturally on aluminium in air and can be thickened by anodizing, to give widely used materials. However, highly localized processes can occur at flaws, which are always present in the films and they can lead to pit development and influence the electrical properties (dielectric breakdown and rectification). As awareness of the different behaviour at flaws increases, other interesting phenomena, such as electroluminescence, response to UV radiation and electrolytic colouring, may be influenced by the activation of preexisting flaws, or the generation of new flaws. Clearly, further knowledge of this kind is of fundamental and practical importance. Some of the more significant findings relating to the nature, shape and geometry of flaws observed after anodizing in ammonium pentaborate solution are outlined here.

(Nature, 286, 5772 (July 31, 1980) pp. 471-72)

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Palaeomagnetism of beach ridges in South Australia and the Milankovitch theory of ice ages
By Mart Idnurm and Peter J. Cook
(Abstract)

Although the Pleistocene glaciations continue to attract new explanations, an early explanation in terms of secular variations of the Earth's orbital elements, the Milankovitch theory, has recently gained considerable support. This theory predicts insolation variations with periodicities of ~ 20,000, 40,000 and 100,000 yr. Its popularity is attributable mostly to deep-sea sediment information on variations of the glaciation-sensitive $^{16}O/^{18}O$ isotopic ratio and the increasingly convincing match of those variations to the Milankovitch climatic curves. Independently, land-based evidence is accumulating in favour of the Milankovitch theory from raised coral terrace, loess, and pollen studies. We discuss here evidence for the Milankovitch theory from a South Australian Sea-level record.

(Nature, 286, 5774 (August, 14, 1980) pp. 699-702)

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Polyphosphazenes, and the inorganic approach to polymer chemistry

By Harry R. Allcock

(Abstract)

Synthetic macromolecules serve a vital function in modern research and technology. However, the 'organic' nature of most of the known polymers places severe limits on their use in medicine or advanced technology. Polymers that contain inorganic elements in the backbone structure offer the promise of solutions to these problems. Poly(organophosphazenes) possess a backbone structure of alternating phosphorus and nitrogen atoms, with two organic groups attached to each phosphorus. They are prepared by an unusual route that allows the tailored synthesis of a wide range of different macromolecules with different side groups and unusual physical and chemical properties. Examples are given of the way in which the unique chemistry of these polymers can be utilized for the synthesis of materials for use in chemotherapy, catalysis, and high technology.

(Science Progress, 66, 263 (Autumn 1980) pp. 355-69)

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SCIENCE NEWS

HUMAN TESTS OF BACTERIA-PRODUCED INSULIN

It's another step forward in the attempt to harness bacteria to fulfill human needs. Eli Lilly and Co. has announced what it believes to be the first testing in humans of a product of the rapidly expanding recombinant DNA technology (SN:3/29/80, p. 203). At a plant in England the pharmaceutical company has begun testing bacterially produced human insulin on eight nondiabetic healthy subjects. The first results of the tests, which began July 14, show bacterially made insulin to be approximately as effective in lowering blood sugar as naturally produced insulin. One subject who received 9.6 units of the insulin had a 36 percent drop in blood sugar. The bacterial product had already been shown effective in laboratory animals.

Facilities to produce insulin with bacterial techniques are already under construction both in Indianapolis, Lilly's U.S. headquarters, and near Liverpool, England. Lilly expects insulin production at the plants, which will cost more than $40 million, to begin in 1982, although "considerable" scientific work, including tests on diabetics, and government approvals must be gained before the insulin can be made commercially available.

The bacterially produced, or "biosynthetic," insulin is identical to that made by the human body (SN: 9/16/78, p. 195). The researchers expect that biosynthetic insulin will reduce the incidence of allergic reactions - a small proportion of diabetics are allergic to the insulin currently available from animal pancreas glands. In addition, the bacterially produced material would answer the concern that animal pancreas glands will be in short supply in about 20 years.

(Science News, 118, 4 (July 26, 1980) p. 53)

BY JOVE - A NEW MOON

Jupiter has another moon, bringing the planet's grand total to 16, or even 17 if some observations from Earth are confirmed. The latest moon, unnamed but designated 1979 J3, showed up on pictures sent back to Earth by the two Voyager spacecraft that flew close to Jupiter last year. It is the second Jovian moon that Stephen Synnott, a project navigator at NASA's Jet Propulsion Laboratory in California, has discovered.

Synnott discovered the 16th moon while looking for evidence to confirm the existence of the 14th (or 1979 J1) - the first moon the Voyager spacecraft spotted. Instead he found an object that could only be another moon.

Prior to the Voyager's mission, astronomers knew that Jupiter had at least 13 moons - four are similar to the Earth's moon but the remaining ones are much smaller. The new moon is no exception, being about 40 kilometers in diameter. It orbits Jupiter every seven hours or so at a distance of some 56,200 km above the planet's cloud tops, close to the outer edge of the ring around the planet that images from Voyager revealed for the first time. The smallness of Jupiter's moons means that they are difficult to see on the pictures from Voyager and Synnott has not yet confirmed the existence of the 14th moon although he has studied hundreds of pictures.

(New Scientist, 87, 1219 (Sept. 18, 1980) p. 837

Huxley for PRS

Sir Andrew Huxley, the neurophysiologist, is now almost certain to be the next President of the Royal Society in succession to Lord Todd, who comes to the end of his five-year stint at the anniversary meeting, to be held this year on 1 December.

The society's election procedures require that nominations of new council members and also of the new president should first be agreed by the Council, and then submitted to the membership of the society in the form of a single slate of candidates. Sir Andrew Huxley's name has apparently been agreed for several months, and it is known that several institutions have already engaged him to speak at conferences or to officiate at centenary celebrations well into 1981.

Now that Sir Andrew's nomination by the council is assured, the chances of his not being elected are vanishingly small. This could only happen if a majority of the members of the society were to strike out his name on the ballot paper and to substitute that of some other member.

Sir Andrew, who will be 63 at his election, has been a Royal Society Research Professor in the Department of Physiology, University College London, since 1969.

(Nature, 287, 5785 (Oct. 30, 1980) p. 771)

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China plays profit

Researchers at the Institute of Physics of the Chinese Academy of Sciences have recently been working on a new project - how to sell their results to industry.

It seems that until the recent economic reforms, what is now officially described as "a lack of communications" and "obstacles inherent in the system" prevented new scientific results from being applied to industry. New findings remained inaccessibly locked away in publications and festchrifts. Consequently, scientists had become upset and frustrated, while factories, unaware of new advances, were unable to modernize.

With the fall of the Gang of Four, however, factory managements were able to approach the scientists for advice on new results and how to apply them. So far, the Institute of Physics has worked out three possible cooperation procedures: (1) outright sale of the new technology, with technical assistance provided until the technology goes into production; (2) contracts for technological guidance, involving sending experts to the factories or training workers at the institute; with the onset of production, the institute is repaid on a sliding scale related to the profits from the new technology; for example, 20% in the first year, 10% in the second, 5% in the third; (3) provision of the new technology, for a decreasing percentage of its profits, for example, 5% the first year, 3% the second, and so on.

(Nature, 287, 5785 (Oct. 30, 1980) p. 773)

FUTURE LOOKS BRIGHT FOR ECONOMIC SOLAR CELLS

Researchers in the US have devised solar cells that performs very efficiently and are cheap to make. Engineers at Boeing Aerospace, under contract to the Department of Energy's Solar Energy Research Institute (SERI), have developed a thin-film solar cell which converts solar energy into electrical energy with an efficiency of 9.4 percent - an increase of about 40 per cent.

Conventional silicon cells can convert solar energy with efficiencies as high as 15 per cent. But to make them costs over £4 for every watt of power they can produce. Boeing's thin-film cells - based on copper indium selenide and cadmium sulphide - could soon have efficiencies of 10 per cent and, by 1990, cost no more than 22p for every watt.

The manufacture of Boeing's thin-film cells is based on vapour deposition. The cell material is heated until it vapourises. Materials scientists can then control the way this vapour settles on a support which can be made from any of several cheap and widely-available materials. In some of the cells under test at SERI's centre in Colorado, the solar-energy converting material forms a layer about 5 micrometres thick. By making thin-film cells with larger surface areas Boeing workers believe that they can further cut the cost.

Scientists in Europe have also developed a technique for making cheap solar cellls. Workers at the Laboratories d'Electronique et de Physique Appliquee in France have covered a carbon base with a thin layer of polycrystalline silicon. Although these cells have conversion efficiencies no greater than 8 per cent, the thickness of the silicon layer can be easily controlled up to 100 micrometres. Also, the technique of "drawing" layers, each comprising large numbers of crystals, from a molten mass is much faster than the conventional method of growing a single silicon crystal from a "seed" crystal.

(New Scientist, 87, 1215 (Aug. 21, 1980) p.590)

CHARCOAL CLOTH

The National Research Development Corporation has invested over £100000 in a joint venture with Charcoal Cloth Ltd of Wimborne, Dorset, to develop and manufacture a new filtration material made of woven charcoal fibres. The cloth combines better filtration properties than the more usual granular charcoal with the advantages of a resistant, flexible cloth material.

Charcoal cloth is composed of 16 μm diameter, 100% activated charcoal fibres in a linen weave cloth with 13 threads per centimetre (cloth weight is 120 gm^2). It has an adsorptive capacity several times greater than existing products made of cloth or foam to which fine charcoal granules have been affixed. The manufacturing process, which is highly integrated and continous, was developed by Dr F A P Maggs at the Chemical Defence Establishment at Porton Down. Woven cloth, made from cellulose fibres, is pre-treated to make the final product flexible and strong and then converted to charcoal in a furnace. The final product weighs less than one-quarter the original weight.

Charcoal cloth has a number of advantages over granular charcoal. It is a strong, flexible medium, and thus does not require a container, is shock and vibration resistant and is up to 5-10 times more effective per unit weight than granular charcoal. Performance deterioration caused by humid conditions is less

Contd. 49/-

than with granular charcoal and the cloth can be regenerated and used more than once, a fact which offsets its relatively high cost. Applications in defence and industrial sectors should be forthcoming, for example in air conditioning in plant and vehicles as well as for protection for instruments and laboratory equipment which must function in clean-air conditions. Water and chemical purification are other possibilities and, in the medical world, bandages incorporating charcoal cloth may remove offensive odours and improve the healing environment. In blood purification the cloth is ideal for the rapid removal of toxins and drugs in the blood.

(Physics in technology, 11, 5 (Sept. 1980) pp. 203-4)

BELGIAN TEAM CLONES INTERFERON

Interferon testing may soon progress at a much greater rate thanks to recent work by Rik Derynck and colleagues at the State University of Ghent, Belgium (Nature, Vol. 287, p 193). Clinical trials using human leukocyte and fibroblast interferon have yielded promising results in the treatment of viral diseases and cancer.
Tests with human fibroblast interferon (HF-IF) have been severely restricted, however by its very limited availability. Derynck has discovered a method in which Escherichia coli, an abundant gut bacterium, can be made to synthesise HF-IF.

A copy of the gene for HF-IF was made and introduced into a plasmid, an extrachromosomal piece of DNA used by geneticists to transport genes, using standard DNA recombination techniques (genetic engineering). Derynck and workers found a way of introducing the plasmid into E. coli such that the bacteria's own systems "read" the gene and produced the interferon. Production can then be switched off and on simply by changing the temperature at which the bacteria is growing. Tests on the bacterially produced HF-IF showed it to have very similar characteristics to the molecule in the body, including having measurable antiviral activity.

The HF-IF yield was low but the workers expect this to improve considerably with practice of the techniques involved. Interferon production by bacteria is of great importance because it will be much quicker, cheaper and yield far more than the lengthy extraction procedures which are used on human tissues at present. The work of Derynck and his colleagues is a major step towards achieving this, as it is the first time that researchers have introduced a complete interferon gene into bacteria and successfully produced active interferon.

(New Scientist, 88, 1224 (Oct. 30, 1980) p. 294)

A NIP IN THE AIR

People who believe that solar activity affects the weather were embarrassed, and their opponents delighted, by recent reports that Chinese naked-eye observations of sunspots show six "sightings" in the 17th century, smack in the middle of the Little Ice Age. This is embarrassing, says our climate

Contd.---50/-

buff, because the Sun weather believers argue that absence of sunspots goes hand in hand with cold weather on Earth. But they can now rest easier in their beds. For D.M. Willis and M.G. Easterbrook, of the Rutherford and Appleton Laboratories, and Richard Stephenson, of the University of Liverpool, have come up with a stunningly simple resolution of the paradox.

It is possible to see sunspots with the naked eye only when there is a haze in the air, such as volcanic dust or wind blown soil. And when is there likely to be a haze in the air over China? Typically, when cold winds blow off the great Gobi and other deserts in late winter or early spring. Sure enough, the records show a clear association between cold years and sunspot sightings (Nature, Vol 287, p 617). The records may not be much use as indicators of solar activity, but they do tell us something about the weather. You only see sunspots in China when there's a nip in the air.

(New Scientist, 83, 1225 (Oct. 30, 1980) p. 319)

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